Memo

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ADEQ

File No: 9101110001.5

From: Stuart Pearson, PE

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CC: Carolyn d'Almeida, USEPA
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Date: November 3, 2015

Re: Summary of MPE Well Groundwater Concentration Screening Methods and Results
Site ST012
Former Williams Air Force Base
Mesa, Arizona

1.0 BACKGROUND

Steam Enhanced Extraction (SEE) is approaching completion and is being evaluated against the criteria for transition to Enhanced Bioremediation (EBR) presented in the Remedial Design and Remedial Action Work Plan (RD/RAWP)(AMEC, 2014). The overall remedy for ST012 includes SEE as the initial phase, followed by active EBR and MNA phases with the goal of reaching cleanup criteria on a timeframe of approximately 20 years after the Record of Decision Amendment 2 (AFCEC, 2013). The purpose of the SEE is to remove light-non-aqueous phase liquids (LNAPL) and bulk contamination mass within the thermal treatment zones (TTZs) established in the RD/RAWP. The purpose of EBR is to provide additional treatment of LNAPL and mass outside the TTZs as well as polishing treatment, if necessary, within the TTZs such that after active EBR, continued degradation will achieve the remedial goals. The criteria to be considered in making the decision to transition from SEE to EBR are established in the RD/RAWP and are summarized as follows (additional detailed explanation is contained in Table 4-2 of the RD/RAWP):

Primary SEE to EBR Transition Criteria

- Achieve target subsurface temperatures
- Diminishing mass removal rates

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Secondary SEE to EBR Transition Criteria

- Completion of Pressure Cycling: Repeat until no additional significant increases in effluent vapor concentrations observed when steam pressure is reduced
- Benzene Concentrations: Target benzene concentration of 100 to 500 µg/L range within the TTZ (interior of the TTZ)
- Steam Injection: Used as a guideline to measure progress vs. design

In the October 16, 2015 BCT conference call, Amec Foster Wheeler and TerraTherm presented data that supports the primary transition criteria have been met. Pressure cycling continues and mass removal associated with pressure cycling is diminishing (secondary transition criteria). Evaluation of benzene concentrations (secondary transition criteria) is ongoing. Amec Foster Wheeler and TerraTherm continue to collect data to evaluate this criteria and sampling is dynamic in response to results received at each round.

As presented in the RD/RAWP, the multiple lines of evidence of the transition criteria will be used to support the decision to terminate steam injection and transition to EBR. The criteria will be considered in total with the weight of evidence from these multiple lines being used for decisions (i.e., the decision will not require absolute achievement of the all criteria). Amec Foster Wheeler and TerraTherm are closely monitoring the performance of the SEE system to evaluate thermal operation and determine when the transition to the next phase is warranted. The evaluation and decision for completion of thermal operations will be made between Amec Foster Wheeler and TerraTherm and discussed with the AF, EPA, and ADEQ prior to termination of steam injection.

2.0 ESTIMATED GROUNDWATER CONCENTRATIONS

Groundwater samples have been collected from select multi-phase extraction (MPE) wells across the site to provide an initial screening level of benzene concentrations throughout the Cobble Zone (CZ), Upper Water Bearing Zone (UWBZ), and Lower Saturated Zone (LSZ). Samples were collected from the MPE sample port utilizing the Hot Groundwater Sample Standard Operating Procedure (located in the Construction Completion Report). Benzene concentrations were estimated at each MPE well using the following inputs collected during the sampling:

- Motive Water Flow Rate;
- Motive Water Benzene Concentration;
- Return Water Flow Rate; and,
- Return Water Benzene Concentration.

Motive water flow rate and return water flow rate are measured by installed flow meters at each well. The flow meters are of the same type, manufacturer, and model for both feed and return flow at each well. Return water concentration is measured in the sample collected at the sample port. Feed water concentrations are measured from a sample collected at the air

stripper influent. Water at the air stripper influent is pulled from the same tank (T-102) that is used to feed motive water to the eductors in the MPE wells. The attached tables provide the supporting data and resulting estimated formation concentrations for each sampling event.

The groundwater extraction rate was estimated at each well sampled based on the difference between the motive and return flows. The equation used is shown below:

$$C_{formation} = \frac{(Q_{return} \times C_{return} - Q_{feed} \times C_{feed})}{(Q_{return} - Q_{feed})}$$

where,

$C_{formation}$ is the calculated formation concentration of benzene [µg/L]
C_{feed} is the feed water concentration of benzene [µg/L]
C_{return} is the return water concentration of benzene [µg/L]
Q_{feed} is the motive water flow rate [gpm]
Q_{return} is the return water flow rate [gpm]

Although the focus of this sampling has been on benzene because of its inclusion in the Steam Enhanced Extraction to Enhanced Bioremediation transition criteria, similar calculations have been performed for other detected VOCs.

Groundwater sampling events utilizing the method described above to estimate benzene concentrations at select MPE wells have occurred:

- 11-12 August 2015 at selected MPE wells (selected for spatial representation across the site) in the CZ, UWBZ, and LSZ;
- 1-2 September 2015 at all MPE wells in the LSZ not previously sampled during the 11-12 August event;
- 8 September 2015 at all MPE wells in the UWBZ;
- 2 October 2015 at select MPE wells in the LSZ with extraction in the CZ and UWBZ turned off for approximately 24-hours prior to sampling (to evaluate the effect that feedwater concentrations have on the calculated benzene concentrations at MPE wells sampled); and,
- 9 and 12 October 2015, select wells in the UWBZ with vapor extraction at those wells turned off for approximately 3 days prior to sampling (to evaluate if steam condensate was contributing to higher dissolved phase benzene concentrations in groundwater samples collected).

During each sampling event, three feedwater samples were collected – one before the MPE well sampling, one near the middle of the sampling period, and one after MPE well sampling completion. For smaller sampling events, only one or two feedwater samples were collected.

3.0 CONCLUSIONS

The groundwater sampling method described above is successful in providing a qualitative measure of the dissolved phase benzene concentrations at individual MPE wells sampled. Variability in the calculated concentrations has been seen and is believed to be caused by flow meter accuracy and to a lesser extent, motive feedwater concentration variability. In addition, the project team has seen better repeatability with the sampling method for MPE wells that have lower calculated dissolved phase benzene concentrations. For MPE wells that contain higher benzene concentrations, the variability in the calculated concentration between events can be large (i.e., greater than 10,000 µg/L). Based on the 9 and 12 October 2015 results, there is no obvious correlation between condensate recovered (or the lack thereof) and calculated benzene concentrations. The project team has used the calculated benzene concentrations to screen the MPE well concentrations based on the following: <500 µg/L (meeting the operational target), 500-2,000 µg/L (approaching the operational target), and >2,000 µg/L (well above operational target). Actual calculated dissolved phase benzene concentrations ranged from less than 500 µg/L to greater than 49,000 µg/L. Benzene concentrations remain elevated in some locations, and while benzene is a secondary criteria, it will be desirable to see more reductions in benzene concentrations and stability in test results at levels below or approaching the target level. Some influence is anticipated from inflow at the perimeter so allowance must be made for this factor in evaluating whether benzene concentrations have been sufficiently reduced in the thermal treatment zones. Benzene mass removal will also continue to occur during the post-injection extraction period. Concentrations less than 500 µg/L are amenable to achieving cleanup criteria by MNA only within the remedy timeframe. Concentrations above 500 µg/L can also achieve cleanup criteria with the addition of active EBR to promote further degradation. The duration and amount of terminal electron acceptor required increase with increasing benzene concentrations. Please see the attached spreadsheet with the calculated dissolved phase benzene concentrations. Note that calculations were performed using preliminary data from the laboratories.